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AE59 Experimental Report

Inverse Compton Scattering of MHz pulse trains

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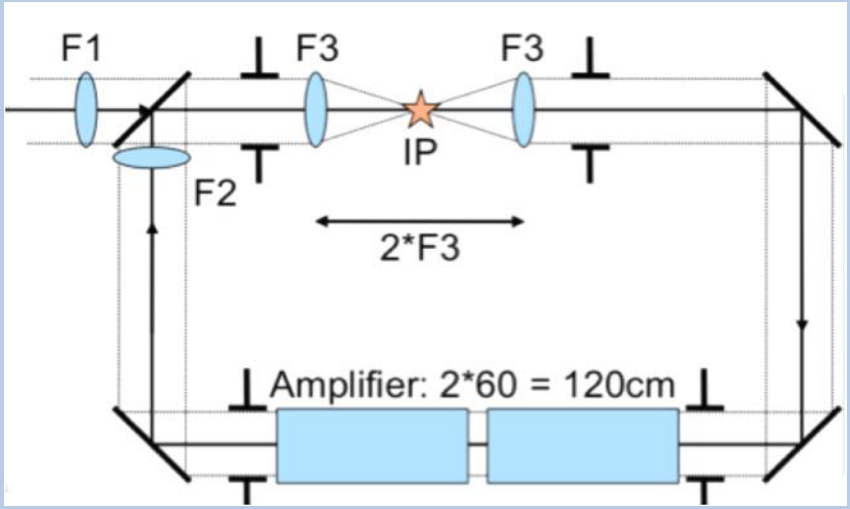
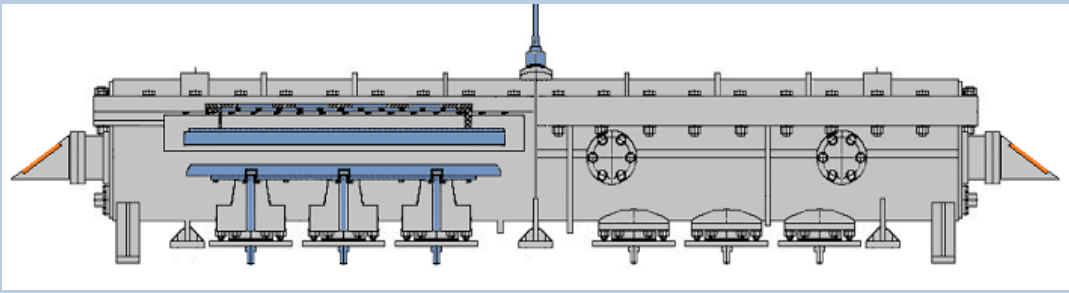
Multi Bunch ICS Experiment - Intro

- Project funded by DOE SBIR Award No. DE-SC0007703.
- Long history of successful ICS interaction at ATF
- Inherent limitations of single-shot experiment
- Existing potential sizeable increase in x-ray generation without increasing core facility capabilities
- Requires laser pulse recirculation
- Requires active reamplification to reach and maintain high per pulse energy

CO2 Active Cavity Overview

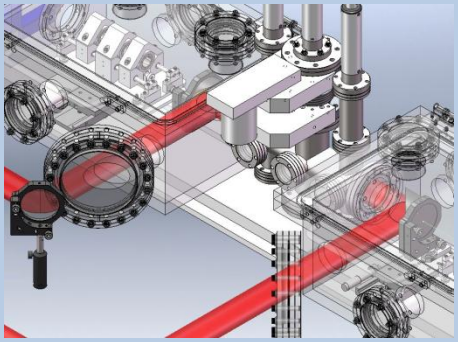
- ATFs 10atm CO2 amplifier enables active pulse reamplification at multi-MHz rates
- Amplification of the initial seed pulse and maintaining a long pulse train

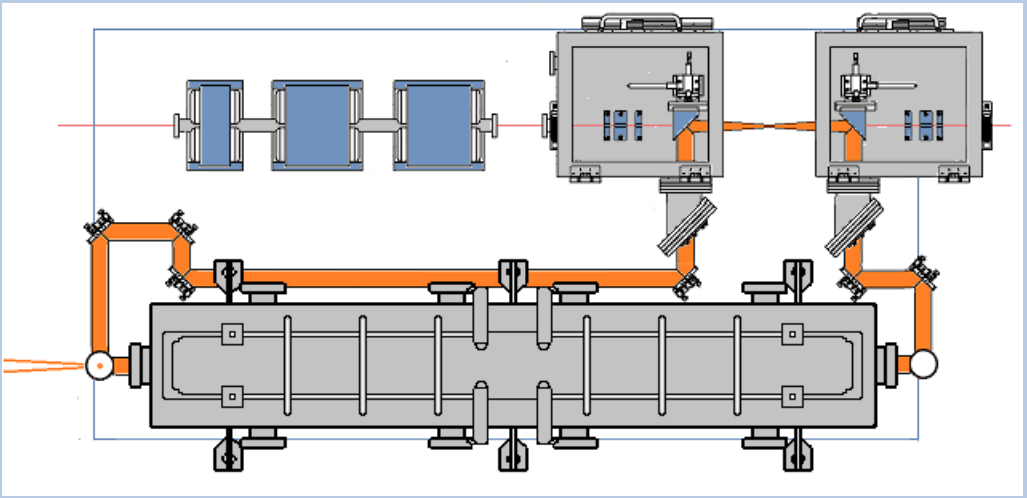




CO2 Cavity Around the Beamline

- 25ns cavity provides sufficient path length to incorporate amplifier into the beamline
- Integrated, 5-axis motorized OAPs
- Built in PMQs for precise e-beam focusing

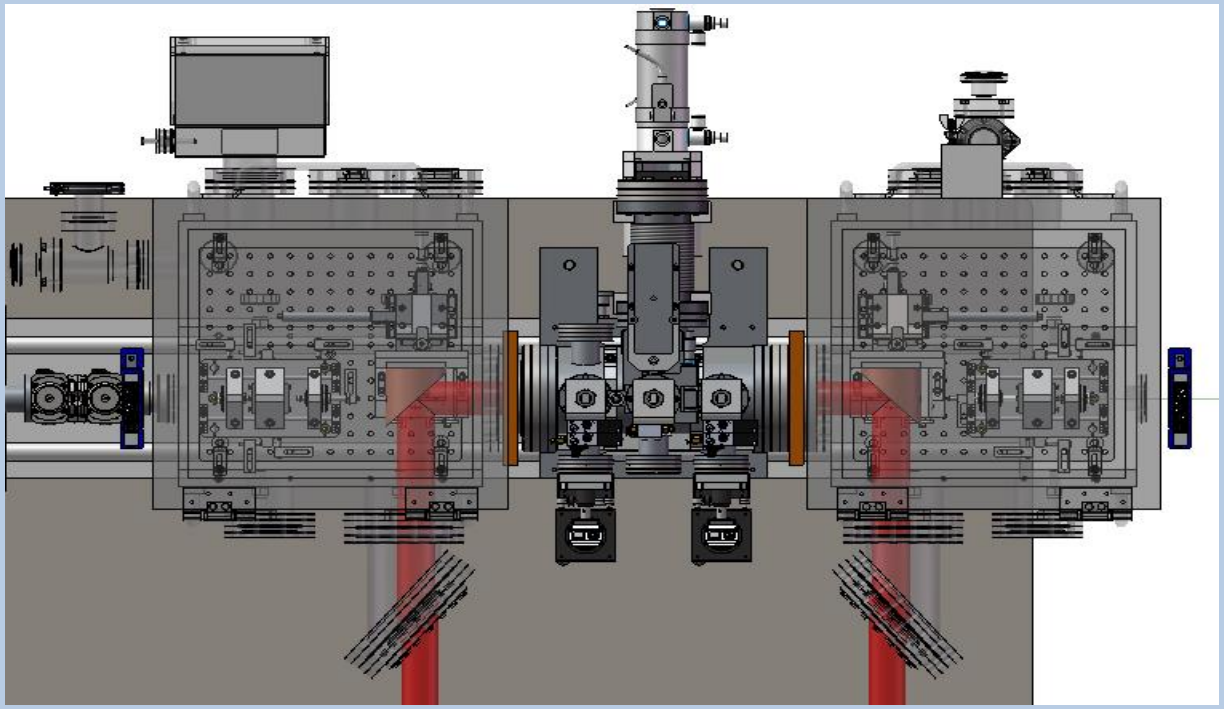




- Potential number of interacting e-beam/laser pulses limited primarily by system alignment accuracy

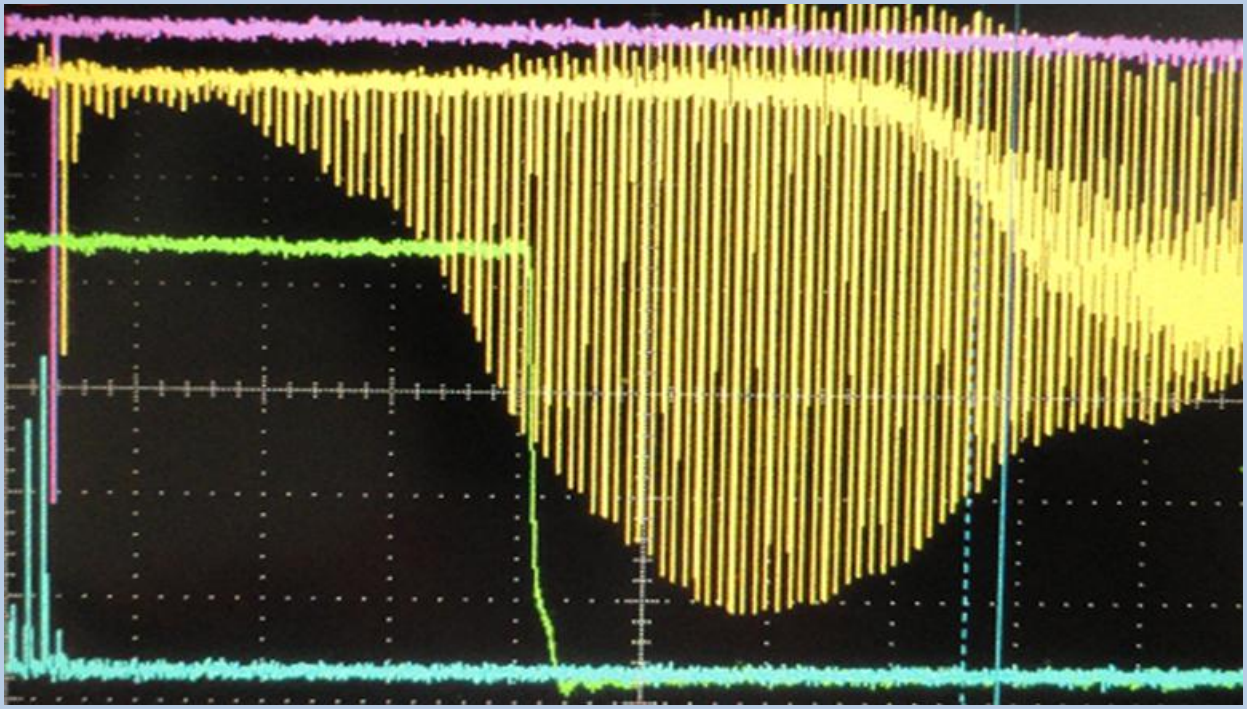
New Vacuum Chamber

- Synergy with UCLA-ATF Program
- Designed for rapid work-pumpdown cycle



- Reuses existing UCLA's X-Ray detector system

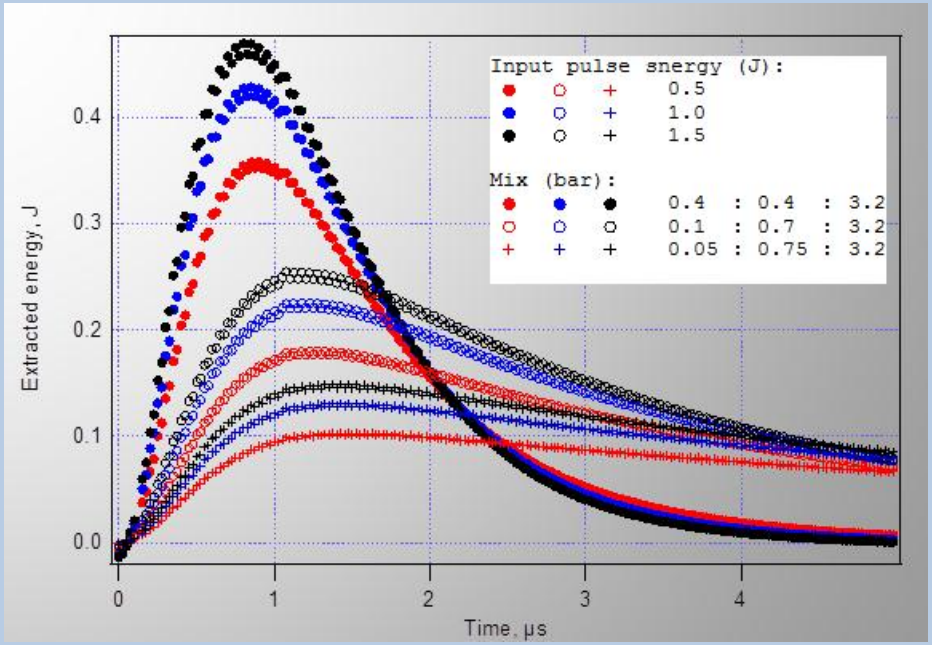
Progress Report - CO2 Intracavity Test

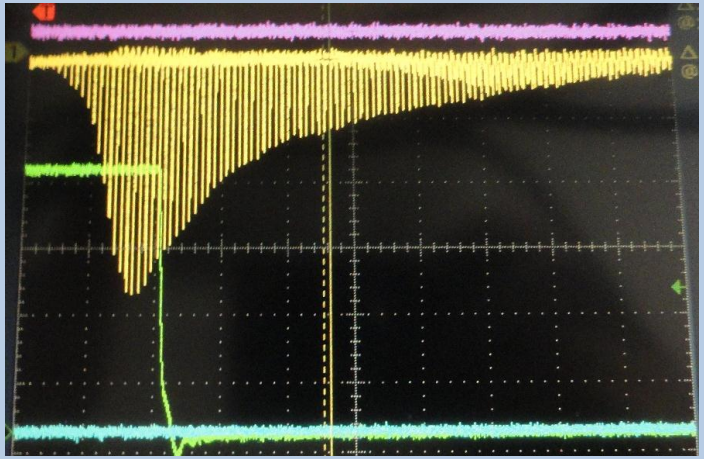


- Established a stable pulse train of 30+J at 40 MHz (Dec'13)

Research on Laser Pulse Train

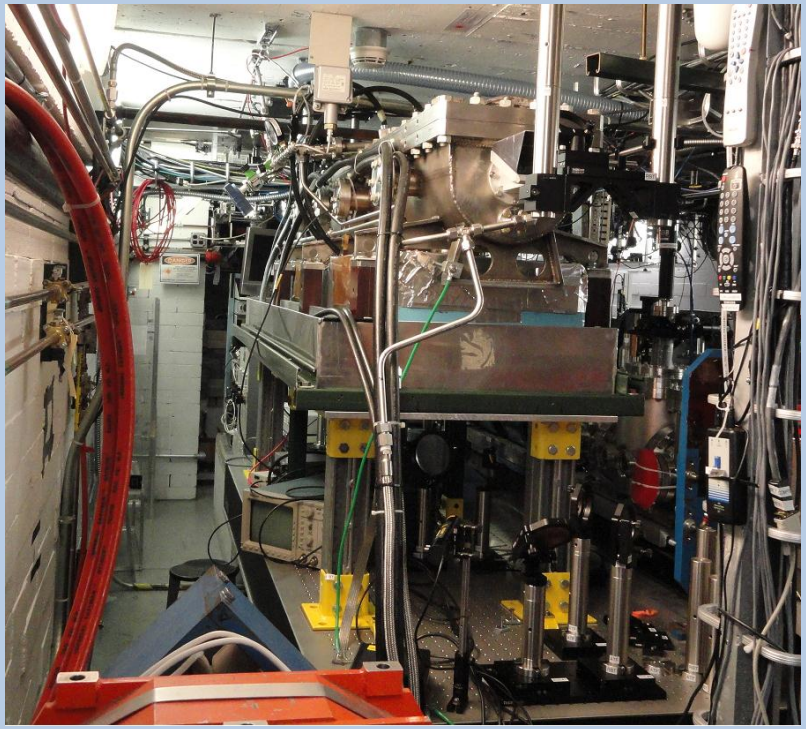
- Evaluated different cavity injection methods
- Investigates the effect of different gas ratios on pulse train shape/duration/energy extraction rate





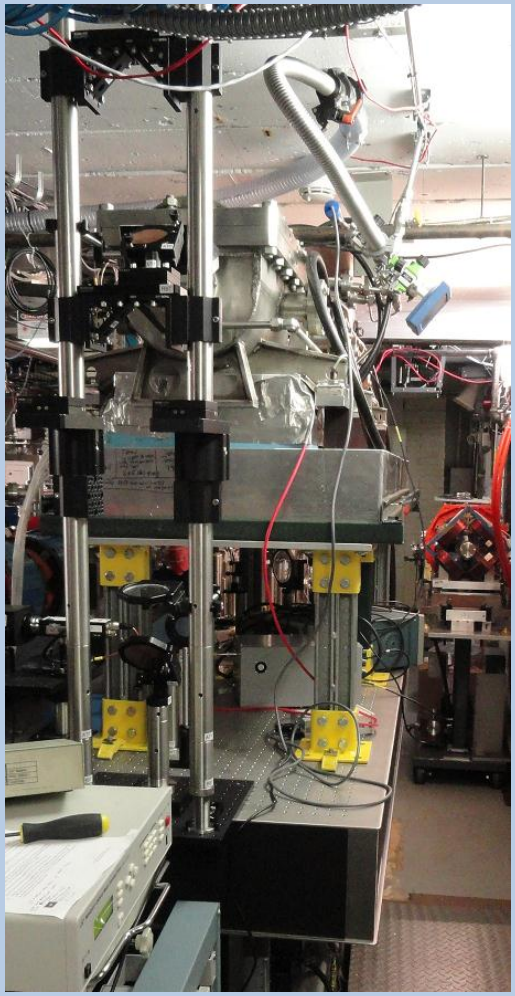
Amplifier Installation in the E-Hall

- Amplifier underwent a complete maintenance cycle between Jan-May



- Installed and commissioned in the experimental hall over the summer
- EUL optics to be arranged underneath the amplifier

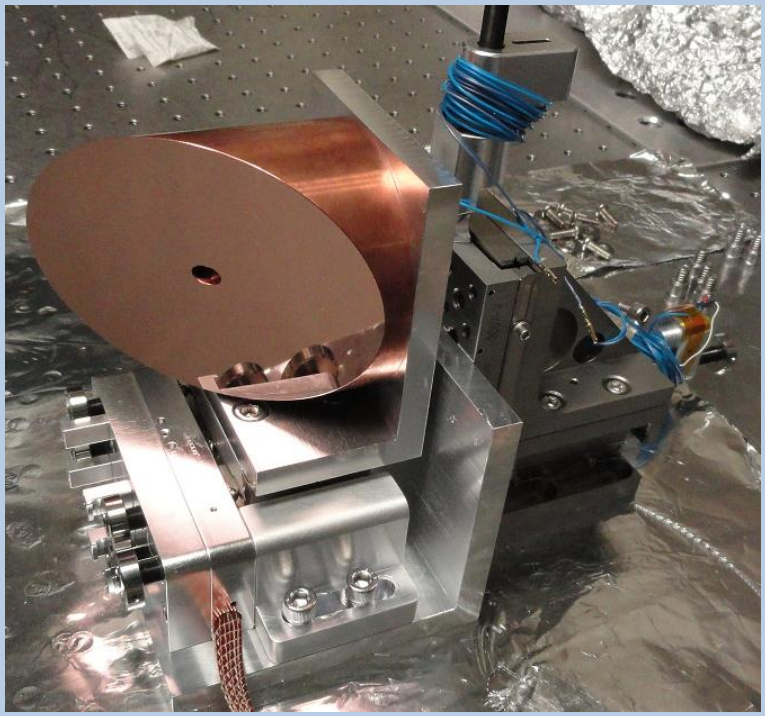
Current Work - Laser System



- New CO2 beam path has been completed
- Amplifier electrical and trigger systems are operational
- Ongoing test of the amplifier with the new 3-5ps seed laser (ATF's upgrade of the core CO2 laser to TI:Sa)

OAPs and Laser Diagnostics Testing

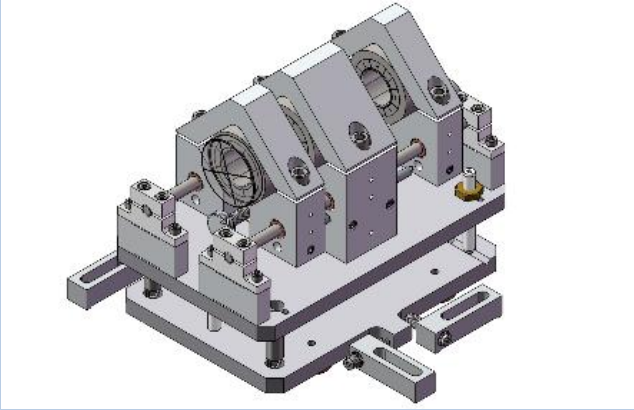
- Ongoing OAP evaluation at ATF
- Motorized controls, pinhole diagnostics via imaging lens
- Characterizing the CO2 beam waist
- Intracavity collimation
- Pockel's Cell to pick out individual pulses out of the train



New 2EUL Chamber and PMQs

- 2EUL Chamber is currently finishing fabrication, last remaining section will be completed in several weeks

- Custom PMQs have been modeled specifically for ATFs beamline



Specs on PMQs and the distances between them for betas=5m, energy 65 MeV

name	L, cm	K1, 1/m2	G, T/m	drifts, cm
PMQ1	2	100	21.67	
PMQ2	3.62	100	21.67	2.6
PMQ3	1.8	100	21.67	1.4
PMQ4	1.8	100	21.67	78.4
PMQ5	3.62	100	21.67	1.4
PMQ6	2	100	21.67	2.6

Future Plans – Vac Chamber and E-Beam

- Installation scheduled for the week of November 17th
- PMQ installation in the empty chamber in early December
- ATF optimizes e-beam propagation through the chamber, achieving target spot size at the IP
- Installation of the OAP assemblies into the chamber, positioning mirror apertures to prevent alignment conflicts with e-beam

Start of the Laser Cavity Alignment Phase

- December – January: preparation for single-shot Compton Interaction
- Includes: installation of laser diagnostics and imaging optics, optimization of IP focal size/position, inter-cavity beam collimation, multi-pass timing
- Reproduce pulse train performance only this time with a beam focus in a specific location over set number of passes

Single-shot ICS

- Estimated either late January or February
- Requires synchronizing e-beam with Nth laser cavity pass (50-100mJ range interaction energy needed)
- Positioning, shielding and calibrating the x-ray detector
- Possibly switching CO2 cavity injection method
- At this point we are replicating the results of UCLA's experiment by utilizing a single pulse from the laser pulse train

Multi-pass Laser Cavity Refinement

- Expected to continue during February-March
- Further optimizing energy distribution in the pulse train to maximize energy in the select number of passes chosen for interaction
- Perfecting inter-pass timing and alignment on the diagnostics pinhole, minimizing drift and collimation problems using the Pockel's Cell to diagnose individual pulses in the chosen segment
- Single shot ICS on select pulses from the laser train

Final ICS Interaction

- Multi-bunch e-beam optimization (timing/IP size/charge) by ATF
- Complex synchronization of e-beam/laser pulse trains
- Final phase lasts during April-May